Proposed TMDL
Environmental Protection Agency

TMDL Report

Nutrient, Dissolved Oxygen, and Biochemical Oxygen Demand TMDL for Delaney Creek
(WBID 1605)

September 29, 2004

United States Environmental Protection Agency

Region 4 serving the southeast

Acknowledgments

EPA would like to acknowledge that the contents of this report and the total maximum daily load (TMDL) contained herein were developed by the Florida Department of Environmental Protection (FDEP). Many of the text and figures may not read as though EPA is the primary author for this reason, but EPA is officially proposing the TMDL for nutrient, dissolved oxygen (DO), and biochemical oxygen demand (BOD) for Delaney Creek and soliciting comment. EPA is proposing this TMDL in order to meet consent decree requirements pursuant to the Consent Decree entered in the case of Florida Wildlife Federation, et al. v. Carol Browner, et al., Case No. 98-356-CIV-Stafford. EPA will accept comments on this proposed TMDL for 60 days in accordance with the public notice issued on September 30, 2004. Should EPA be unable to approve a TMDL established by FDEP for the 303(d) listed impairment addressed by this report, EPA will establish this TMDL in lieu of FDEP, after full review of public comment.

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TMDL Program

http://www.dep.state.fl.us/water/tmdl/index.htm

Identification of Impaired Surface Waters Rule

http://www.dep.state.fl.us/water/tmdl/docs/AmendedIWR.pdf

STORET Program

http://www.dep.state.fl.us/water/storet/index.htm

2000 305(b) Report

http://www.dep.state.fl.us/water/305b/index.htm

Criteria for Surface Water Quality Classifications

http://www/dep.state.fl.us/legal/legaldocuments/rules/ruleslistnum.htm

Basin Status Report for the Tampa Bay Basin

http://www.dep.state.fl.us/water/tmdl/stat_rep.htm

Water Quality Assessment Report for the Tampa Bay Basin

http://www.dep.state.fl.us/water/tmdl/stat_rep.htm

Allocation Technical Advisory Committee (ATAC) Report

http://www.dep.state.fl.us/water/tmdl/docs/Allocation.pdf

U.S. Environmental Protection Agency, National STORET Program

http://www.epa.gov/storet/

Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Load (TMDL) for nutrients, dissolved oxygen (DO), and biochemical oxygen demand (BOD) impairments in the freshwater segment of Delaney Creek in the Tampa Bay Basin. Using the methodology to identify and verify water quality impairments described in the Impaired Waters Rule (IWR), Chapter 62-303, Florida Administrative Code (FAC), the stream was verified as impaired for DO, and was included on the Verified List of impaired waters for the Tampa Bay Basin that was adopted by Secretarial Order on August 28, 2002. This TMDL establishes the allowable nutrient and BOD loadings to Delaney Creek that would restore the waterbody so that it meets the applicable water quality standard for DO. The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions.

1.2 Identification of Waterbody

The Delaney Creek watershed is located in Hillsborough County, with a 22.6-square-mile drainage area flowing into the southeastern portion of East Bay **(Figure 1.1).** The Delaney Creek freshwater stream segment is a third-order stream, and, along its length, it exhibits characteristics associated with riverine aquatic environments. The watershed includes a large area of Brandon, a rapidly expanding urban area in central Hillsborough County. In its headwaters, east of Interstate 75, the creek consists of a series of stormwater ponds. West of the interstate, the creek flows through a channel for approximately 6.5 miles before it enters East Bay. One industrial facility, Nitram, Inc., a producer of ammonia nitrate, has a permitted discharge of 0.41 million gallons per day (mgd).to Delaney Creek at the lower portion of the freshwater reach. **Figure 1.2** shows the Delaney Creek watershed and long-term water quality stations and flow gage. Additional information about the river's hydrology and geology are available in the Basin Status Report for the Tampa Bay Basin (Florida Department of Environmental Protection, November 2001).

For assessment purposes, the Florida Department of Environmental Protection (the Department) has divided the Tampa Bay Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. The Delaney Creek watershed has been divided into six WBIDs or water segments listed below. This TMDL addresses the DO impairment for the main freshwater stream segment, WBID 1605. Lake Ten Mile, Lake Ten Mile Drain, Gornto Lake, and Mead Lake drain into the freshwater segment.

- 1605 Delaney Creek
- 1605A Lake Tenmile
- 1605A1 Lake Tenmile Drain
- 1605B Gornto Lake
- 1605C Mead Lake
- 1605D Delaney Creek Tidal

1.3 Background

This report was developed as part of the Florida Department of Environmental Protection's (Department) watershed management approach for restoring and protecting state waters and addressing TMDL Program requirements. The watershed approach, which is implemented using a cyclical management process that rotates through the state's fifty-two river basins over a five-year cycle, provides a framework for implementing the TMDL Program–related requirements of the 1972 federal Clean Water Act and the 1999 Florida Watershed Restoration Act (FWRA, Chapter 99-223, Laws of Florida).

A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet water quality standards, including its applicable water quality criteria and its designated uses. TMDLs are developed for waterbodies that are verified as not meeting their water quality standards. TMDLs provide important water quality restoration goals that will guide restoration activities.

This TMDL Report will be followed by the development and implementation of a Basin Management Action Plan, or BMAP, to address impairment in the Delaney Creek watershed. These activities will depend heavily on the active participation of the Southwest Florida Water Management District, Hillsborough County's Environmental Protection Commission (HCEPC), local governments, businesses, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDLs for impaired waterbodies.

Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rule-Making History

Section 303(d) of the federal Clean Water Act requires states to submit to the EPA a list of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant source in each of these impaired waters on a schedule. The Department has developed these lists, commonly referred to as 303(d) lists, since 1992. The list of impaired waters in each basin is also required by the FWRA (Subsection 403.067[4)] Florida Statutes [F.S.]). Florida's 1998 303(d) list included 47 waterbodies in the Tampa Bay Basin; the list is amended annually to include updates for each basin statewide.

However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rule-making process, the Environmental Regulation Commission adopted the new methodology as Chapter 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001. The list of waters for which impairments have been verified using the methodology in the IWR is referred to as the Verified List.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in Delaney Creek and has verified the impairments listed in **Table 2.1**. **Table 2.2** summarizes the DO data for the verification period. The stream was verified as impaired for DO because greater than 10 percent of the Delaney Creek DO assessed values exceeded the Class III freshwater DO criterion of 5 mg/L. The period used to identify impairment for water segments for the 2002 303(d) listing is January 1995 to June 2002.

Figure 2.1 displays the DO results based on the IWR assessment methodology for the verified period (January 1995 to June 2002). The verified impairments for Delaney Creek are based on data collected at the long-term HCEPC monitoring station (21FLHILL138) displayed in **Figure 1.2**. The individual water quality measurements used in the assessment are presented in **Appendix B**.

The DO concentration in water results from several physical, biological, and chemical processes. Low DO concentrations may be caused by several factors including the decay of oxygen demanding waste from point and non-point sources, conversion of ammonia to nitrate by bacteria, algal and macrophyte respiration, excessive epiphyte or floating macrophyte growth blocking light to submerged aquatic vegetation, and sediment oxygen demand. The oxidation and reduction of introduced chemical compounds such as metals, pesticides, aromatic hydrocarbons, and other organic chemical compounds also deplete oxygen levels. At the physical level, oxygen solubility occurs at the air-water interface and depends on water temperature, atmospheric pressure, and salinity. Higher temperature reduces oxygen solubility in water, contributing to a reduction in the DO concentration. Equilibrium is reached when the percent saturation for dissolved oxygen in water is at 100 percent. Another physical process, stream reaearation, introduces atmospheric oxygen back into the water column. Reaeration is a function of stream hydraulics and channel geometry. The reaeration rate increases with increasing velocity and decreases, as the stream becomes deeper.

Nutrients can also influence DO levels indirectly. Algal populations can increase rapidly if nutrients are available and the production of oxygen as a result of photosynthesis during daylight hours and respiration or consumption of oxygen from the water column at night can result in large diurnal fluctuations of DO in the water column. A fraction of increased algal biomass will also become part of the organic material that will be broken down by microbes or settle to the bottom. Ammonia concentrations may also effect DO by conversion of ammonium to nitrate (nitrification) where oxygen is consumed by aerobic nitrifying bacteria. Processes that consume oxygen from the water column such as microbial breakdown of organic material and sediment oxygen demand are fairly constant over the short term.

Based on available information in the Delaney Creek watershed, it appears that the DO impairment is related to organic enrichment which exerts a biochemical oxygen demand (BOD) in the water column. In ambient waters, most organic contaminants are degraded by bacterial metabolism. The BOD determines the amount of oxygen used in the metabolism of biodegradable organic compounds and BOD is a common indicator of the degree of contamination of surface waters by organic pollutants. Phytoplankton, suspended algae, biomass is relatively low in the stream and is not expected to have much of an influence on DO concentrations. During the verified period, individual and annual average chlorophyll *a* concentrations were well below the threshold of nutrient impairment for streams of 20 μg/L.

The organic enrichment noted above is based on the intricate relationship between carbonaceous biochemical oxygen demand (CBOD), nitrogenous biochemical oxygen demand (NBOD), total organic nitrogen (TON), and ammonia as nitrogen (NH3-N). TON and NH3-N are components of NBOD. CBOD is a measure of the total amount of oxygen required to degrade the carbonaceous portion of the organic matter present in the water. NBOD is the amount of oxygen utilized by bacteria as they convert ammonia to nitrate. Because organic nitrogen can be converted to ammonia, its potential oxygen demand is included in NBOD. In Delaney Creek, CBOD and NBOD are suspected of contributing to the low dissolved oxygen concentrations (see Chapter 5).

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criteria Applicable to the TMDL

Florida's surface waters are protected for five designated use classifications, as follows:

Class I	**Potable water supplies**
Class II	**Shellfish propagation or harvesting**
Class III	**Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife**
Class IV	**Agricultural water supplies**
Class V	**Navigation, utility, and industrial use (there are no state waters currently in this class)**

The freshwater segment of Delaney Creek is a Class III waterbody with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criteria applicable to the observed impairment addressed in this TMDL are the DO and narrative BOD criteria.

3.2 Applicable Water Quality Standards and Numeric Water Quality Target

3.2.1 DO Criterion

The Class III freshwater criterion for DO, as established by Subsection 62-302.530(31), F.A.C., states that DO shall not be less than 5.0 mg/L, and normal daily and seasonal fluctuations above these levels shall be maintained.

3.2.2 Interpretation of Narrative BOD Criterion

Florida's BOD criterion is narrative only and states that BOD shall not be increased to exceed values which would cause DO to be depressed below the limit established for each class and, in no case, shall it be great enough to produce nuisance conditions.

For this study, the Department applied the Alabama Department of Environmental Management (ADEM) Spreadsheet Water Quality Model (SWQM) in Delaney Creek to determine the appropriate BOD loading for the DO TMDL. The modeling assessment indicated that even under natural background conditions for the critical low DO event simulated, the DO criterion of 5 mg/L can not be achieved.

For the purpose of this TMDL, a dissolved oxygen water quality target was established based on the model simulation for natural background conditions. Natural background was defined as

100 percent forest land cover thoughout the watershed being modeled. The pollutant concentrations associated with forest cover were used in the ADEM Spreadsheet Water Quality Model to predict the natural background DO concentration for the critical low DO event simulated. To establish the TMDL, pollutant loadings for CBODu and NBOD were derived by reducing the existing load to achieve a DO prediction that was within 0.2 mg/L of natural background conditions. The DO target selected for this TMDL is a concentration 4.1 mg/L.

Chapter 4: ASSESSMENT OF SOURCES

4.1 Types of Sources

An important part of the TMDL analysis is the identification of pollutant source categories, source subcategories, or individual sources of nutrients in the Delaney Creek watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either "point sources" or "nonpoint sources." Historically, the term point sources has meant discharges to surface waters that typically have a continuous flow via a discernable, confined, and discrete conveyance, such as a pipe. Domestic and industrial wastewater treatment facilities (WWTFs) are examples of traditional point sources. In contrast, the term "nonpoint sources" was used to describe intermittent, rainfall driven, diffuse sources of pollution associated with everyday human activities, including runoff from urban land uses, agriculture, silviculture, and mining; discharges from failing septic systems; and atmospheric deposition.

However, the 1987 amendments to the Clean Water Act redefined certain nonpoint sources of pollution as point sources subject to regulation under the EPA's National Pollutant Discharge Elimination Program (NPDES). These nonpoint sources included certain urban stormwater discharges, including those from local government master drainage systems, construction sites over five acres, and a wide variety of industries (see **Appendix A** for background information on the federal and state stormwater programs).

To be consistent with Clean Water Act definitions, the term "point source" is used to describe traditional point sources (such as domestic and industrial wastewater discharges) **<u>and</u>** stormwater systems requiring an NPDES stormwater permit when allocating pollutant load reductions required by a TMDL. However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES stormwater discharges and non-NPDES stormwater discharges, and as such, this source assessment section does not make any distinction between the two types of stormwater.

4.2 Point Sources

4.2.1 NPDES Permitted Wastewater Facilities

There is one NPDES permitted facility, Nitram, Inc., in the Delaney Creek watershed. However, the Nitram permit (FL0001643) was inactivated in the latter part of 2003, and Nitram is now seeking to update its permit to allow for stormwater discharges only. The NPDES permit remains active requiring routine monitoring of the discharge for BOD, turbidity, total nitrogen, total kjeldahl nitrogen, ammonia, and temperature. The discharge is located at the downstream end of the freshwater reach and HCEPC station 138 is located near but upstream of the discharge outfall to the creek (Richard Boler personal communication). Linear regression analyses were performed to determine if any of the effluent parameters were directly associated with the low DO conditions. None of the analyses performed suggested that the effluent discharge could be linked to the low DO. From the time when the discharge was discontinued, there has been no observable change in the DO levels.

4.2.2 Municipal Separate Storm Sewer System Permittees

Within the Tampa Bay Basin, the stormwater collection systems owned and operated by Plant City, Hillsborough County, and the Florida Department of Transportation for Hillsborough County are covered by an NPDES municipal separate storm sewer system (MS4) permit, FLS000006. Hillsborough County is the lead co-permittee for the Delaney Creek Watershed. In October 2000, Hillsborough County drafted a watershed management plan involving berm construction, channel improvements, and structural upgrades for flood control and some water quality treatment. Other recommendations for the Delaney Creek watershed were to begin a study identifying sources of untreated discharges and begin providing treatment through Best Management Practices (BMPs) to reduce the loadings. The Hillsborough Planning and Growth Management Department is in the process of a septic tank study for the watershed that identifies the location of septic tanks, assesses their impacts on water quality, and recommends management techniques to improve their efficiency. It was proposed to design vegetation maintenance activities that removed vegetation from system rather than cutting or herbiciding, which leads to muck or detritis build up.

In October 2000, EPA authorized FDEP to implement the NPDES stormwater program in all areas of Florida except Indian Country lands. FDEP's authority to administer the NPDES program is set forth in Section 403.0885, Florida Statutes (F.S.). The NPDES stormwater program regulated point source discharges of stormwater into surface waters of the State of Florida from certain municipal, industrial, and construction activities. The NPDES stormwater permitting program is separate from the State's stormwater/environmental resource permitting program, and local stormwater/water quality programs, which have their own regulations and permitting requirements.

4.3 Land Uses and Nonpoint Sources

Loadings from urban areas is most often attributable to multiple sources including storm water runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals. With the Delaney Creek basin being primarily urban, wildlife, and agricultural animals/livestock sources are not expected to contribute significantly to the any loads.

The total nonpoint source loads for each pollutant were quantified based on land use areas in the basin. The loadings include runoff from urban areas, and transportation and utility areas. Parts of the surface runoff loads are loads coming from atmospheric deposition that fall directly onto the land surface. Although not specifically quantified, the runoff from residential areas includes leachate from septic systems.

Onsite sewage treatment and disposal systems (OSTDs), including septic tanks, are commonly used where providing central sewer is not cost-effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTD is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, OSTDs can be a source of nutrients (nitrogen and phosphorus), pathogens, and other pollutants to both ground water and surface water. As of 2001, Hillsborough County has roughly 100,483 septic systems (DOH, 2003). This total does not reflect systems removed from service going back to 1970. To date, FDEP does not have the percent of population using septic systems in

Hillsborough County or estimates of county wide failure rates to determine daily discharge of wastewater from septic tanks.

Nonpoint source loadings from surface runoff for total nitrogen, total phosphorus, and BOD were estimated using the Watershed Management Model (WMM) which is based on the imperviousness and event mean concentrations (EMCs) from different land use types in the watershed. The spatial distribution and acreage of different land use categories were identified using the 1999 Southwest Florida Water Management District's land use coverage (scale 1:40,000) contained in the Department's GIS library (DEP BIS, 2004).

4.3.1 Land Uses

The Delaney Creek watershed drains about 11,807 acres (18.4 square miles) into the southeastern part of East Bay. Land use categories in the watershed were aggregated using the Level 1 and Level 3 1999 Florida Land Use and Cover Classification System (FLUCCS) and are tabulated in **Table 4.1** and displayed in **Figure 4.1**. The predominant land use in the watershed is urban and built-up areas which comprises 68 percent of the area. The next largest land use, agriculture, makes up nine percent of the area.

4.3.2 Estimating Nonpoint Loadings

The nonpoint source loadings generated in the Delaney Creek watershed were estimated using the Watershed Management Model. The annual loads are calculated from 1995 to 2003. The annual loadings were then averaged to provide an annual average loading for the 1995 to 2003 period.

Estimating Loadings Using the Watershed Management Model.

The Watershed Management Model (WMM) was used to estimate the nonpoint source loadings for the Delaney Creek watershed. WMM is designed to estimate annual or seasonal pollutant loadings from a given watershed and evaluate the effect of watershed management strategies on water quality (User's Manual: Watershed Management Model, 1998). The Department originally funded the WMM development under contract to Camp Dresser and McKee (CDM), and CDM has subsequently refined the model. The strength of the model is its capability to characterize pollutant loadings from nonpoint sources (such as those from stormwater runoff, stream baseflow, and leakage of septic tanks). While, the model also handles point sources such as discharges from wastewater treatment facilities and the estimation of pollution load reduction from partial or full-scale implementation of on-site or regional best management practices (BMPs), the TMDL focused on the nonpoint source characterization for total nitrogen, total phosphorus and BOD.

The fundamental assumption of the model is that the amount of stormwater runoff from any given land use is in direct proportion to annual rainfall. That fraction of the land use category that is characterized as impervious and the runoff coefficients of both pervious and impervious area control the quantity of runoff. The governing equation is as follows:

(1) $\mathbf{R_L = [C_p + (C_I - C_p)\, IMP_L] * I}$

Where:
R_L = total average annual surface runoff from land use L (in/yr);

IMP_L = fractional imperviousness of land use L;
I = long-term average annual precipitation (in/yr);
C_P = pervious area runoff coefficient; and
C_I = impervious area runoff coefficient.

The model estimates pollutant loadings based on nonpoint pollution loading factors (expressed as lbs/ac/yr) that vary by land use and the percent imperviousness associated with each land use. The pollution loading factor, M_L, is computed for each land use L by the following equation:

(2) $M_L = EMC_L * R_L * K$

Where:

M_L = loading factor for land use L (lbs/ac/yr);
EMC_L = event mean concentration of runoff from land use L (mg/L); EMC varies by land use and pollutant;
R_L = total average annual surface runoff from land use L computed from Equation (1) (in/yr); and
K = 0.2266, a unit conversion constant.

The data required for applying the WMM include the following:

- Area of all the land use categories and the area served by septic tanks,
- Percent impervious area of each land use category,
- EMC for each pollutant type and land use category,
- Percent EMC of each pollutant type that is in suspended form,
- Annual precipitation

Data Required for Estimating TN, TP, and BOD Loadings. To estimate loadings from the Delaney Creek watershed using WMM, the following data were obtained:

A. Rain precipitation data were obtained from the weather station located at the Tampa International Airport (NWS Station 88788). The total annual rainfall amounts from 1995 to 2003 were retrieved from the Climate Interactive Rapid Retrieval User System (CIRRUS) hosted by the Southeast Regional Climate Center (see **Figure 4.2**)

B. Areas of different land use categories were obtained by aggregating GIS land use coverage based on the simplified Level 1 code. The freshwater land use coverage was delineated by the estuarine polygon boundary, 1605D. It was also determined that a subbasin generally bounded on the north by Crosstown Expressway, on the east by I-75, and on the west by S. 86th Street, drained southward into a channel that flows out of the Delaney Creek watershed (see **Figure x.x**). The Delaney Creek drainage area encompasses 16 square miles. These areas and the percent of each land use category are listed in **Table 4.2.** The dominant land use category for the watershed is urban open, which accounts for about 27 percent of the total area of the watershed. Medium-density residential accounts for another 19.9 percent of the total watershed area. In total the area of human land use categories cover 76.5 percent of the total area of the freshwater drainage area.

C. Percent impervious area of each land use category is a very important parameter in estimating surface runoff using the WMM. Nonpoint pollution monitoring studies throughout the United States over the past fifteen years have shown that annual per-acre discharges of urban stormwater pollution are positively related to the amount of imperviousness in land use (User's Manual: Watershed Management Model, 1998). Ideally, the *impervious area* is the area that does not retain water and therefore, 100 percent of the precipitation falling on the impervious area should become surface runoff. In practice, however, the runoff coefficient for impervious area typically ranges between 95 and 100 percent. Impervious runoff coefficients lower than this range were observed in the literature, but usually the number should not be lower than 80 percent. For pervious area, the runoff coefficient usually ranges between 10 and 20 percent. However, values lower than this range were also observed (User's Manual, 1998). In this study, the values for impervious and pervious runoff coefficients were obtained from the Watershed Management Model User's Manual (CDM, 1998) and Brown, M.T., "The South Dade Watershed Project," Center for Urban & Community Design, U of M.

D. Local event mean concentrations (EMC) of TN, TP, and BOD for different land use categories were obtained from the report entitled, "Evaluation of Alternative Stormwater Regulations for Southwest Florida" (Harvey and Baker, 2003) and are presented in **Table 4.3**.

Summary of the Loadings into Delaney Creek from Various Sources. The total pollutant loading can be expressed as follows:

(3) $\mathbf{T_L = \sum T_{NPSu}}$

Where:

T_L = total loading (lbs/year) for the Delaney Creek watershed
$\sum T_{NPSu}$ = sum of nonpoint source total loadings (lbs/year) in the freshwater portion of the Delaney Creek watershed determined by WMM.

Estimated Surface Runoff and Loadings Using WMM

Tables 4.4, 4.5, and 4.6 list the annual surface runoff and Total Nitrogen, Total Phosphorus, and BOD loads, respectively, from different land use categories estimated using the WMM for the 1995 to 2003 period. **Figures 4.3, 4.4, and 4.5** display the relative contribution from each land use category based on the calculated annual average values. The charts show that high density residential land use contributes the largest percentage of loading, followed medium density residential.

Table 4.7 summarizes the annual average TN and BOD loadings to Delaney Creek. The estimated TN and BOD annual average loadings for the 1995 to 2003 period are 74,882 lbs/year and 268,888 lbs/year, respectively. During this nine year period, the minimum annual loads occurred in 2000, the lowest rainfall year, and maximum loads occurred in 1997, the highest rainfall year. These loading estimates represent the maximum amount of loadings generated in the freshwater segment of the basin.

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Overall Approach

The goal of this TMDL development is to identify the maximum allowable biochemical oxygen demand loading to the Delaney Creek watershed so that the freshwater stream segment will meet the dissolved oxygen (DO) target and maintain its function and designated use as a Class III water. The following two steps were taken to achieve this goal.

1. Using the ADEM Surface Water Quality Model (SWQM), estimate the oxygen demanding loads from nonpoint sources that will meet the established DO target for the critical low DO event simulated.

2. Apply the percent load reduction needed to meet the DO target to the annual BOD and TN loads estimated using the Watershed Management Model (see Chapter 4).

5.2 Water Quality Model Backgorund

The ADEM Spreadsheet Water Quality Model (SWQM) is a steady-state model relating dissolved oxygen concentration in a flowing stream to total organic nitrogen (TON), carbonaceous biochemical oxygen demand (CBOD), ammonia as nitrogen (NH_3-N), nitrogenous biochemical oxygen demand (NBOD), sediment oxygen demand (SOD) and reaeration. The model allows the loading of CBOD, NBOD, and SOD to the stream to be partitioned among different land uses (nonpoint sources).

The SWQM is based on the Streeter-Phelps dissolved oxygen deficit equation with modifications to account for the oxygen demand resulting from nitrification of ammonia (nitrogenous oxygen demand) and the organic demand found in the waterbody sediment. The modified Streeter-Phelps equation takes into account the oxygen demand due to carbonaceous decay plus the oxygen demand generated from the nitrification process (ammonia decay). The equation below shows the Streeter-Phelps relationship with the additional components to account for nitrification and SOD (ADEM, 2001).

$$\textbf{(1)} \quad D = \frac{K_d L_0}{K_a - K_d}\left(e^{-K_d t} - e^{-K_a t}\right) + \frac{K_{NH_3} N_0}{K_a - K_{NH_3}}\left(e^{-K_{NH_3} t} - e^{-K_a t}\right) + \frac{SOD}{K_a H}(1 - e^{-K_a t}) + D_0 e^{-K_a t}$$

Where: D = dissolved oxygen deficit at time t, mg/l
L_0 = initial ultimate CBOD, mg/l
N_0 = initial NBOD, mg/l (NBOD = NH_3-N x 4.57)
D_0 = initial dissolved oxygen deficit, mg/l

K_d = CBOD decay rate, 1/day
K_a = reaeration rate, 1/day
K_{NH3} = nitrification rate, 1/day
SOD = sediment oxygen demand, g O_2/ft^2/day
H = average stream depth, ft
t = time, days

The ADEM has a SWQM model guidance document that explains the theoretical basis for the physical/chemical mechanisms and principles that form the foundation of the model (Alabama Department of Environmental Management, 2001).

The spreadsheet water quality model (SWQM) developed by the ADEM was selected for this TMDL for the following reasons:

- It is a simplified approach with the ability to modify model inputs to conform with specific stream characteristics;

- It conforms to DEP standard practices for developing load and wasteload allocations;

- It lends itself to being developed with limited water quality data and flow data; and

- It has the ability to handle tributary inputs and both point and nonpoint
- source inputs.

The spreadsheet model also provides a complete spatial view of a stream, upstream to downstream, showing differences in stream hydraulics and water chemistry at various locations along the model reach.

5.3 Model Scenarios for TMDL Development

The ADEM SWQM was used to estimate the nonpoint source loadings of carbonaceous biochemical oxygen demand (CBOD), total organic nitrogen (TON), ammonia as nitrogen (NH3-N), and nitrogenous biochemical oxygen demand (NBOD) needed to meet the DO target at the critical low DO event simulated. The pollutant load for the TMDL is expressed as the ultimate carbonaceous biochemical oxygen demand ($CBOD_u$) and nitrogenous biochemical oxygen demand (NBOD). NBOD is the amount of oxygen utilized by bacteria as they convert ammonia to nitrate. Because organic nitrogen can be converted to ammonia, its potential oxygen demand is included in the NBOD component of the TMDL.

Three SWQM model scenarios were utilized in developing the target DO concentration and corresponding oxygen demanding load. The “calibrated” model is the primary SWQM model used in developing the Delaney Creek DO TMDL. The forest land cover model and 72 percent load reduction model were developed from the calibrated model to estimate the loadings for this TMDL. The three SWQM models and their corresponding organic loading results are provided in **Appendix C** (calibrated model), **D** (forest model), and **F** (72 percent load reduction model).

The calibrated model is based on what is considered a critically low DO event in the stream. The critical DO condition for this study was a sampling event where the DO was approximately at the lower 15th percentile ranking of the data collected at HCEPC station 138 from 1995 to 2002. The critical DO sampling event was in the mid-range of flow conditions based on the Delaney Creek flow record at USGS gage 02301750.

The May 19, 1999 sampling event, where the DO measured was 1.4 mg/L, was selected as the critical low DO event for the calibration model. The stream flow recorded on this date was 3.8 cfs. The model was set up based on conditions observed on this date and input values (reaction rates and concentrations) were adjusted to match the observed data for model calibration.

After the model was calibrated to the May 19, 1999 sampling event, the forest land cover model, where all land use in the freshwater segment was converted to forest, was used to estimate the DO concentration under natural background conditions. The natural background DO was estimated to be 4.3 mg/L. The DO target used in this TMDL is 4.1 mg/L, to allow for loadings associated with human development that would not considerably lower the DO from natural background conditions.

Model load reduction scenario iterations were then performed to determine the load reductions necessary to meet the target. It was determined that a 72 percent reduction in existing oxygen demanding loads under the critical low DO event would meet the DO target of 4.1 mg/L.

5.4 Delaney Creek Spreadsheet Water Quality Model Development

The data used in the application of the SWQM include the following:

- Area of all the land use categories within the segmented watershed,
- Event Mean Concentrations for each pollutant type and land use category,
- Ambient water quality and flow data,
- Pervious area runoff coefficients,
- Groundwater conditions for baseflow analysis,
- Stream topography,
- Reaction rates

A. Subasin Delineations

The freshwater segment of the Delaney Creek Basin was divided into eight subbasins for modeling purposes. These subbasins include the headwaters, two tributaries, and subbasins adjacent to the five stream segments chosen to reppresent the stream channel. The freshwater stream segment of Delaney Creek modeled is approximately 4.9 miles in length and flows into WBID 1605D, the estuarine segment of the basin. A headwaters input, two tributary inputs, and five subbasin inputs were included in the SWQM. The five creek segments were assumed to be homogeneous reaches and each received inflow from their adjacent subbasins.

B. Areas of Different Land Use Categories

The freshwater basin of the Delaney Creek watershed was subdivided into individual segments to account for changes in the physical features of the stream as shown in **Figure x.x**. As shown, the basin was divided by considering flow from tributaries, the outflow of the flood relief channel (see Chapter 4), and changes in major land uses. Each segment's different land use categories were obtained in a similar manner as described in Chapter 4 for the WMM, by aggregating GIS land use coverage based on the simplified Level 1 FLUCCs. The watershed was segmented into 8 subbasins and designated as the following: headwaters, tributary A, tributary B, and segments 1-5.

C. Local Event Mean Concentrations (EMC)

Local event mean concentrations of BOD and TN for different land use categories for Southwest Florida were obtained from Harper and Baker, 2003. Since the model is able to incorporate the hydrolysis of organic nitrogen and the nitrification of ammonia, the EMC for total nitrogen was fractionated by nitrogen species. The fraction of organic nitrogen, and ammonia present in total nitrogen was calculated for each sampling event at HCEPC 138 data from 1995 to 2002. Then the median value of organic nitrogen fraction and ammonia fraction was determined for that period and used as the concentration fraction (PC_F) in the following equation:

$$\textbf{(2)} \quad EMC_S = \frac{EMC_L \times C_p \times PC_F}{\sum(\%L \times C_p)}$$

Where: EMC_S = event mean concentration of runoff from land use for the segment expressed as mg/L,
EMC_L = event mean concentration of runoff from land use L (mg/L); EMC varies by land use and pollutant,
C_p = pervious area runoff coefficient for the land use,
PC_F = concentration fraction for the pollutant,
PC_F = 0.082 for ammonia,
PC_F = 0.643 for organic nitrogen,
PC_F = 1.5 for ultimate CBOD, and
%L = percent of land use category in the segment.

The ultimate CBOD concentration fraction is a common value used to estimate ultimate CBOD from $CBOD_5$ results. For each segment an EMC was calculated, varying according to the segment's land use category and pollutant.

D. Flow Estimations

Estimated flows in **Table 5.2** were based on data from USGS gage 02301750 for May 19, 1999, which was reported as 3.80 cubic feet per second (cfs). The USGS gage is geographically located in the lower western portion of the Delaney Creek watershed (**Figure 1.2**). The flow data represents only the upstream section of the watershed and does not include any flow addition caused by point sources, runoff, or tributaries below the gage. To assign flows for the headwaters and tributaries the total watershed flow was calculated by taking the gaged flow result and multiplying it by a watershed area ratio (total area/gaged watershed area) of 1.23 to give 4.69 cfs. Next, any flow resulting from groundwater was determined by applying a baseflow separation formula that estimated the contribution to be 0.64 cfs for the entire freshwater basin of Delaney Creek. The baseflow was subtracted out from the total watershed flow and the result, 4.04 cfs, multiplied by a segment area ratio (segment area/total area).

Incremental inflow refers to all natural stream flow not considered by the other two sources of natural flow – headwaters and tributaries. It encompasses flows from small tributaries not considered in the model and nonpoint source runoff. For segments without external flow inputs, the flow of 4.04 cfs was multiplied by the segment's area ratio.

Effluent flow refers to any point source discharge that enters into the stream. For the purposes of the model, the baseflow estimation was treated as a point source that entered into the stream at the base of the headwater segment. In this way, the baseflow accounts for the groundwater contributions throughout the watershed.

E. Segment Water Quality Concentrations for $CBOD_u$, NH_3-N, and TON

The model estimated the pollutant concentrations that vary by land use, by the following equation:

$$\textbf{(3)}\quad \mathbf{PC} = \frac{\sum (\%L/100 \times EMC_S \times Q_S)}{Q_S}$$

Where: PC = pollutant concentration (mg/L)
%L = percent of land use category in the segment.
EMC_S = event mean concentration of runoff from land use for the segment expressed as mg/L, and
Q_S = flow for the segment (cfs)

With the exception of the effluent (baseflow) conditions, calculations from equation 3 were used as model inputs for $CBOD_u$, NH_3-N, and TON. Concentrations values for baseflow were based on unconfined surficial groundwater well data collected in the Tampa Bay area (Florida Department of Environmental Protection Groundwater Database, 2004). A groundwater $CBOD_5$ value of 0.5 mg/L was assumed as input since there were no measurements of BOD in the groundwater database. Groundwater database mean values for NH_3-N initially used as input, were adjusted in the model to facilitate model calibration.

F. Segment Water Quality Concentrations for Temperature and DO

The temperature was considered constant throughout the watershed. For all segments, the temperature input was given 24.2° Celsius. The temperature input for the baseflow (effluent) was considered slightly lower than ambient temperature at 24.0° Celsius.

The DO concentration value was determined by using 79.5 percent of the DO saturation concentration (8.42 mg/L) at 24.2° Celsius for the segments having ambient flow conditions (headwaters and tributaries). For the segments with incremental flow, the DO concentration value was determined by using 70 percent of the DO saturation concentration at 24.2° Celsius.

For the baseflow, groundwater database mean values were used initially and adjusted in the model to facilitate model calibration.

G. Segment Stream Characteristics

Velocity at which a stream is flowing is an important factor affecting the dissolved oxygen depletion. Generally, higher velocity results in higher reaeration rates and less pronounced sag in the dissolved oxygen sag curve. However, higher velocity may shift the location at which the minimum dissolved oxygen concentration occurs as more organic material is carried further downstream.

The stream velocity equation is computed by the SWQM by an empirical relationship developed by EPA for streams in the Southeast.

$$\textbf{(4)} \quad \mathbf{V = 0.144Q^{0.4}(Slope)^{0.2} - 0.2}$$

Where: V = velocity, feet/second,
Q = stream flow (cfs), and
Slope = stream slope, feet/mile

Stream flow is an incremental addition to the headwater flow as the water travels downstream in the watershed. The stream length in a segment, the upstream elevation, and the downstream elevations determines slope.

H. Reaction Rates

Reaction rates input section requirements are the carbonaceous BOD decay rate (K_d of 0.3/day), nitrification rate (K_{NH3} of 0.3/day), hydrolysis rate (K_{TON} of 0.05/day), and the reaeration rate (K_a). All reaction rates are assumed to be at 20°C. The 20°C reaeration rate was calculated by the model using the formula developed by E. C. Tsivoglou.

$$\textbf{(5)} \quad \mathbf{K_a = C(Slope)(V)}$$

Where: K_a = reaeration rate at 20°, 1/day,
C = Tsivoglou coefficient
C = 1.8 when stream flow < 10 cfs,
C = 1.3 when stream flow > 10 cfs and < 25 cfs,
C = 0.88 when stream flow > 25 cfs,
Slope = stream slope, feet/mile, and
V = velocity, feet/second

Optional input reaction rates also include average stream depth, TON, CBOD, and SOD settling rate. Sediment oxygen demand (SOD) may be an important part of the oxygen demand budget in shallow streams. However, for shallow streams with sand and mineral soils, the SOD component is generally small. These hydrogeological conditions are representative of the Delaney Creek watershed. It is believed, therefore, that the SOD for this stream is minimal.

5.5 Source Assessment

Both point and non-point sources may contribute CBOD and NBOD (i.e., organic loading) to a given waterbody. As noted in Chapter 4, there are no point sources in the Delaney Creek watershed that are included in this TMDL. Potential sources of organic loading are numerous and often occur in combination. In rural areas, storm runoff from row crops, livestock pastures, animal waste application sites, and feedlots can transport significant organic loading. Nationwide, poorly treated municipal sewage comprises a major source of organic compounds that are hydrolyzed to create additional organic loading. Urban storm water runoff, sanitary sewer overflows, and combined sewer overflows may also be significant sources of organic loading.

Nutrient and organic loadings appear to be generated strictly from nonpoint sources. Potential nonpoint sources of nutrient and organic loading in the Delaney Creek watershed were identified based on an evaluation of 1999 land use information in the watershed. The source assessment was used as the basis for development of the model.

The largest land use area is high and medium density residential homes which make up 33 percent of the watershed, followed by urban open areas that cover about 28 percent (Table 4.1). These land uses are the major sources of nutrient and organic loadings within the basin. Each land use has the potential to contribute to organic loading in the watershed due to organic material on the land surface that is washed off into the receiving waters during heavy rainfall and/or storm events. Compared to other land uses in the watershed, organic enrichment from forested land, nurseries/vineyards, and open land is considered to be small. However, organic loading can originate from forested areas and open land due to the presence of wild animals such as deer, raccoons, turkeys, and waterfowl. Control of these sources is usually limited to land best management practices (BMPs) and may be impracticable in most cases.

5.6 TMDL Development Approach Using the SWQM

Data collected at station HCEPC station 138 in May 1999 were used as input into the SWQM for model calibration. The model calibration plots are provided in Appendix C. After the calibration process was complete, load reduction design runs were performed to attempt to bring the waterbody into compliance with the 5 mg/L DO criterion. The design runs indicated the criterion could not be achieved under the critical low DO event simulated.

Subsequently, land use indicative of natural background conditions (i.e., 100 percent forested land) was incorporated into the model to establish a target threshold. This was accomplished by replacing all the existing land use with forested land use in the calibrated model. The forested land use condition model resulted in an "average" DO concentration of 4.3 mg/L along the five creek segments. The Department selected a target 0.2 mg/L below the natural background DO. Meeting a DO target of 4.1 mg/L, would not considerably lower the DO from natural background conditions and still allow for an anthropogenic loading to the watershed.

Model load reduction scenario iterations were then performed to determine the reductions in existing loads needed to meet the target. Nonpoint source load reductions were simulated by reducing the land use EMCs, used in calibration, an equal percentage throughout the watershed being modeled. It was determined that a 72 percent reduction in the EMCs, or oxygen demanding loads, under the critical low DO event would meet the DO target of 4.1 mg/L. The loads of $CBOD_u$ and NBOD for the 72 percent load reduction run subtracted from the existing loads for the calibration run indicate the amount the load has to be reduced for the critical low DO event. A summary of the water quality concentrations and pollutant loads obtained from the calibrated model, forested model, and 72 percent load reduction model are presented in **Table 5.3.**

The CBODu and NBOD load reductions (based on reductions in EMC values) required to achieve the DO target concentration was established by comparing the existing loading with the allowable load under the critical low DO condition. The actual needed load reduction was calculated using the following equation:

$$\mathbf{LoadReduction} = \frac{\mathbf{ExistingLoad} - \mathbf{AllowableLoad}}{\mathbf{ExistingLoad}} \times \mathbf{100\%}$$

The lowest DO concentrations observed throughout the verified period occurred during the summer months, however, low DO values have been observed thoughout the year. To develop the TMDL on an annual basis, the 72 percent load reduction is applied to the annual average BOD and TN loadings for the 1995 to 2003 period, estimated using the WMM. The reduction in the existing BOD and TN annual load by 72 percent would address the reductions in organic loading needed to meet the DO target using the SWQM. Applying the percent load reduction, developed for the critical low DO condition, on an annual basis provides for an implicit margin of safety in TMDL development.

5.7 Critical Conditions

Lower flow summer conditions are generally considered critical conditions for dissolved oxygen in streams. The higher summer temperatures increase microbial metabolism which consumes more oxygen and reduced water velocities under low flows results in decreased reaeration rates. Also in Florida’s summer wet season, higher organic loadings would occur due to greater surface runoff and lower flows would increase the organic loading residence time. This increased time permits more organic matter decay to occur. Reaction rates for $CBOD_u$ and NBOD (i.e., organic loading) increase with higher temperatures resulting in an increase in the decay process that depletes the dissolved oxygen supply in the water column.

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. The goal of the TMDL development for Delaney Creek is to identify the maximum allowable nutrient and organic loadings to the watershed so that the freshwater segment will meet applicable water quality standards and maintain its function and designated use as a Class III water.

A TMDL is expressed as the sum of all point source loads (Waste Load Allocations, or WLAs), nonpoint source loads (Load Allocations, or LAs), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\textbf{TMDL} = \sum \textbf{WLAs} + \sum \textbf{LAs} + \textbf{MOS}$$

As discussed earlier, the WLA is broken out into separate subcategories for wastewater discharges and stormwater discharges regulated under the NPDES Program:

$$\textbf{TMDL} \cong \sum \textbf{WLAs}_{\textbf{wastewater}} + \sum \textbf{WLAs}_{\textbf{NPDES Stormwater}} + \sum \textbf{LAs} + \textbf{MOS}$$

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because a) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is also accounted for within the LA, and b) TMDL components can be expressed in different terms (for example, the WLA for stormwater is typically expressed as a percent reduction, and the WLA for wastewater is typically expressed as mass per day).

WLAs for stormwater discharges are typically expressed as “percent reduction” because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges also differs from the permitting of most wastewater point sources. Because stormwater discharges cannot be centrally collected, monitored, and treated, they are not subject to the same types of effluent limitations as wastewater facilities, and instead are required to meet a performance standard of providing treatment to the “maximum extent practical” through the implementation of BMPs.

This approach is consistent with federal regulation 40 CFR § 130.2[I] (USU.S. Environmental Protection Agency, 2003), which states that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or other appropriate measure.

As discussed in Section 5.3, this TMDL was established by developing an alternative DO target because modeling indicated that the state Class III freshwater DO criterion of 5.0 mg/L could not be achieved under critical DO conditions. This TMDL provides the basis for an alternative DO criterion of 4.3 mg/L for the creek based on natural background conditions. However, the amount of data on which this report is based are limited. The Department plans to collect additional data in order to develop a Site Specific Alternative Criterion (SACC) for DO in Delaney Creek. As additional information become available, the TMDLs may be updated. The Delaney Creek TMDLs that address the DO impairment are expressed in terms of pounds (lbs) per year of BOD and TN and represent the maximum organic loadings the freshwater segment of Delaney Creek can assimilate to achieve the DO target of 4.1 mg/L. The nonpoint source pollutant load targets for BOD and TN needed to achieve the DO target for this TMDL are provided in **Table 6.1.**

6.2 Load Allocation (LA)

As described in Chapters 4 and 5, the nonpoint source loadings for this TMDL were estimated using the Watershed Management Model and the ADEM Spreadsheet Water Quality Model (SWQM). The LA to nonpoint sources is 75,289 lbs/year of BOD and 20,967 lbs/year of TN (**Table 6.1**). The annual nonpoint source loadings for the TMDL are based on the maximum amount of pollutant load that is generated in the freshwater segment of the watershed.

6.3 Wasteload Allocation (WLA)

6.3.1 NPDES Wastewater Discharges

There are no permitted NPDES wastewater discharges to Delaney Creek that are part of this TMDL. As such, the WLA for wastewater discharges is not applicable.

6.3.2 NPDES Stormwater Discharges

The WLA for stormwater discharges with a Municipal Separate Storm Sewer System (MS4) permit is a 72 percent reduction in BOD and TN loading, which is the same percent load reduction that is required for nonpoint sources to meet the allowable loading of 75,289 lbs/year of BOD and 20,967 lbs./year of TN **(Table 6.1)**. It should be noted that any MS4 permittee will only be responsible for reducing the loads associated with stormwater outfalls for which it owns or otherwise has responsible control, and is not responsible for reducing other nonpoint source loads within its jurisdiction.

6.4 Margin of Safety (MOS)

TMDLs must address uncertainty issues by incorporating a margin of safety in the analysis. The margin of safety is a required component of a TMDL and accounts for the uncertainty about the relationship between pollutant loads and the quality of the receiving waterbody (CWA section 303(d)(1)(c)). Considerable uncertainty is usually inherent in estimating nutrient and organic loading from nonpoint sources, as well as predicting water quality response. The effectiveness of management measures (e.g., stormwater management plans) in reducing loading is also subject to uncertainty.

There are two methods for incorporating a margin of safety (MOS) in TMDL analysis: (1) by implicitly incorporating a MOS using conservative model assumptions to develop allocations, or

(2) by explicitly specifying a portion of the TMDL as the MOS and using the remainder for allocations. Consistent with the recommendations of the Allocation Technical Advisory Committee (Florida Department of Environmental Protection, 2001), an implicit MOS was used in the development of this TMDL. The reduction in the existing BOD and TN annual load by 72 percent is based on the reduction in nutrient and organic loading needed to meet the DO target for the critical low DO condition. Applying the percent load reduction, developed for the critical low DO condition, on an annual basis provides for an implicit margin of safety in TMDL development.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

7.1 Basin Management Action Plan

Following the adoption of this TMDL by rule, the next step in the TMDL process is to develop an implementation plan for the TMDL, which will be a component of the Basin Management Action Plan (BMAP) for McKay Bay. This document will be developed over the next year in cooperation with local stakeholders and will attempt to reach consensus on more detailed allocations and on how load reductions will be accomplished. The BMAP will include the following:

- Appropriate allocations among the affected parties,
- A description of the load reduction activities to be undertaken,
- Timetables for project implementation and completion,
- Funding mechanisms that may be utilized,
- Any applicable signed agreement,
- Local ordinances defining actions to be taken or prohibited,
- Local water quality standards, permits, or load limitation agreements, and
- Monitoring and follow-up measures.

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Appendices

Appendix A: Background Information on Federal and State Stormwater Programs

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C.

The rule requires the state's water management districts (WMDs) to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a SWIM plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, stormwater PLRGs have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka. No PLRG has been developed for Newnans Lake at the time this study was conducted.

In 1987, the U.S. Congress established Section 402(p) as part of the federal Clean Water Act Reauthorization. This section of the law amended the scope of the federal NPDES stormwater permitting program to designate certain stormwater discharges as "point sources" of pollution. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific Standard Industrial Classification (SIC) codes, construction sites disturbing five or more acres of land, and master drainage systems of local governments with a population above 100,000, which are better known as municipal separate storm sewer systems (MS4s). However, because the master drainage systems of most local governments in Florida are interconnected, the EPA has implemented Phase 1 of the MS4 permitting program on a countywide basis, which brings in all cities (incorporated areas), Chapter 298 urban water control districts, and the Florida Department of Transportation throughout the fifteen counties meeting the population criteria.

An important difference between the federal and state stormwater permitting programs is that the federal program covers both new and existing discharges, while the state program focuses on new discharges. Additionally, Phase 2 of the NPDES Program will expand the need for these permits to construction sites between one and five acres, and to local governments with as few as 10,000 people. These revised rules require that these additional activities obtain permits by 2003. While these urban stormwater discharges are now technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that cannot be easily collected and treated by a central treatment facility similar to other point sources of pollution, such as domestic and industrial wastewater discharges. The Department recently accepted delegation from the EPA for the stormwater part of the NPDES Program. It should be noted that most MS4 permits issued in Florida include a re-opener clause that allows permit revisions to implement TMDLs once they are formally adopted by rule.

Table 2.1. Verified Impairements in Delaney Creek, WBID 1605

Parameters Causing Impairment	Priority for TMDL Development	Projected Year for TMDL Development
Fecal Coliform	High	2003
Total Coliform	High	2003
Dissolved Oxygen	High	2003

Note: The parameters listed in **Table 2.1** provide a complete picture of the impairment in the river, but this TMDL only addresses dissolved oxygen impairment.

Table 2.2. Summary Dissolved Oxygen Data for Delaney Creek, WBID 1605

Number of Samples	Minimum (mg/L)	Mean (mg/L)	Median (mg/L)	Maximum (mg/L)	Number of Exceedances
83	0.00	2.79	4.27	9.10	54

Table 4.1. Classification and Percent Distribution of Land Use Categories in the Delaney Creek Watershed

Code	Land Use	Acreage	Percent Distribution
1000	Urban open	3,249	27.51%
1100	Low-density residential	844	7.15%
1200	Medium-density residential	2,123	17.99%
1300	High-density residential	1,815	15.37%
2000	Agriculture	1,076	9.11%
3000/7000	Rangeland	327	2.77%
8000	Transportation, communication, and utilities	673	5.70%
4000	Forest/rural open	816	6.91%
5000/6000	Water/wetland	885	7.50%
	Total	11,807	100.00%

Table 4.2. Classification and Percent Distribution of Land Use Categories in the Delaney Creek Freshwater Drainage Area

Code	Land Use	Acreage	Percent Distribution
1000	Urban open	2,784	27.12%
1200	Medium-density residential	2,041	19.89%
1300	High-density residential	1,775	17.29%
2000	Agriculture	958	9.34%
1100	Low-density residential	801	7.81%
5000/6000	Water/wetland	672	6.55%
4000	Forest/rural open	623	6.07%
8000	Transportation, communication, and utilities	452	4.40%
3000/7000	Rangeland	158	1.54%
	Total	10,262	100.00%

Table 4.3. Land Use Runoff Concentrations (Event Mean Concentrations) in Southwest Florida

FLUCCS ID	Land Use	BOD (mg/L)	Total N (mg/L)	Total P (mg/L)
4000	Forest/rural open	1.23	1.09	0.046
1000-(1100+1200+1300)	Urban open	7.4	1.12	0.18
2000	Agriculture	3.8	2.32	0.344
1100	Low-density residential	4.3	1.64	0.191
1200	Medium-density residential	7.4	2.18	0.335
1300	High-density residential	11.0	2.42	0.49
8000	Communication and transportation	6.7	2.23	0.27
3000+7000	Rangeland	3.8	2.32	0.344
5000	Water	1.6	1.60	0.067
6000	Wetlands	2.63	1.01	0.09

[1] Source: Harper and Baker, 2003.

Table 4.4. Surface Runoff and Estimated Annual Average Total Nitrogen Loadings (1995-2003)

Land Use	Area (acre)	Annual Average Runoff (acre-feet)	Percent Runoff	Annual Average TN load (lbs)	Percent of total TN
Forest/Rural Open	623	418	3.42%	1,240	1.66%
Urban Open	2,784	528	4.31%	1,607	2.15%
Agricultural	958	1,264	10.34%	7,976	10.65%
Low density residential	801	885	7.24%	3,947	5.27%
Medium density residential	2,041	2,776	22.70%	16,455	21.97%
High density residential	1,775	4,945	40.43%	32,540	43.46%
Communication/Highways	452	1,283	10.49%	7,783	10.39%
Rangeland	158	106	0.87%	668	0.89%
Water	300	618	5.05%	1,698	2.27%
Wetlands	372	353	2.88%	969	1.29%

Table 4.5. Surface Runoff and Estimated Annual Average Total Phosphorus Loadings (1995-2003)

Land Use	Area (acre)	Annual Average Runoff (acre-feet)	Percent Runoff	Annual Average TP load (lbs)	Percent of total TP
Forest/Rural Open	623	418	3.42%	52	0.42%
Urban Open	2,784	528	4.31%	258	2.09%
Agricultural	958	1,264	10.34%	1183	9.58%
Low density residential	801	885	7.24%	460	3.72%
Medium density residential	2,041	2,776	22.70%	2,529	20.48%
High density residential	1,775	4,945	40.43%	6,589	53.35%
Communication/Highways	452	1,283	10.49%	942	7.63%
Rangeland	158	106	0.87%	99	0.80%
Water	300	618	5.05%	151	1.23%
Wetlands	372	353	2.88%	86	0.70%

Table 4.6. Surface Runoff and Estimated Annual Average Biological Oxygen Demand Loadings (1995-2003)

Land Use	Area (acre)	Annual Average Runoff (acre-feet)	Percent Runoff	Annual Average BOD load (lbs)	Percent of total BOD
Forest/Rural Open	623	418	3.42%	1,340	0.52%
Urban Open	2,784	528	4.31%	10,619	3.95%
Agricultural	958	1,264	10.34%	13,063	4.86%
Low density residential	801	885	7.24%	10,349	3.85%
Medium density residential	2,041	2,776	22.70%	55,857	20.77%
High density residential	1,775	4,945	40.43%	147,911	55.01%
Communication/Highways	452	1,283	10.49%	23,384	8.70%
Rangeland	158	106	0.87%	1,095	0.41%
Water	300	618	5.05%	2,690	1.00%
Wetlands	372	353	2.88%	2,522	0.94%

Table 4.7 Delaney Creek WMM Annual Average Loadings from 1995 to 2003

Year	Annual TN load (lbs)	Annual BOD load (lbs)
1995	81,960	294,303
1996	74,814	268,640
1997	102,522	368,137
1998	83,808	300,936
1999	52,752	189,424
2000	45,197	162,294
2001	60,187	216,119
2002	93,982	337472
2003	78,720	282,668
Annual Average	74,882	268,888

Table 5.1 ADEM SWQM Event Mean Concentrations for the Delaney Creek Watershed

FLUCCS ID	Land Use Attributes	CBODu EMC[1] (mg/L)	NH3-N EMC[2] (mg/L)	TON EMC[3] (mg/L)
4000	Forest/Rural Open	1.85	0.089	0.701
1000 (1100+1200+1300)	Urban Open	11.10	0.092	0.720
2000	Agriculture	5.70	0.189	1.491
1100	Low Density Residential	6.45	0.134	1.054
1200	Medium Density Residential	11.10	0.178	1.401
1300	High Density Residential	16.50	0.198	1.56
8000	Communication and Transportation	10.05	0.182	1.434
3000 + 7000	Rangeland	5.70	0.187	1.491
5000 + 6000	Water/ Wetlands	3.95	0.083	0.649

1: Default value from Florida State/EPA Region IV Agreement on the Development of Wasteload Allocations and Wastewater Permit Limitions.
2: TN EMC value (Harvey and Baker 2003) multiplied by ratio of NH3-N to TN at station HCEPC 138.
3: TN EMC value (Harvey and Baker 2003) multiplied by ratio of Organic N to TN at station HCEPC 138.

Table 5.2 Delaney Creek Flow Input Data for Modeled Segments

				Percent
Stream Flow at USGS Gage	3.80	Headwaters	6,537	63.7
Baseflow at USGS Gage	0.52	Tributary A	428	4.2
Stream Flow at HCEPC 138	4.69	Tributary B	594	5.8
Baseflow at HCEPC 138	0.64	Segment 1	356	3.5
Total Runoff Flow	1.04	Segment 2	940	9.2
Headwaters	2.58	Segment 3	62	0.6
Tributary A	0.17	Segment 4	1,226	11.9
Tributary B	0.23	Segment 5	120	1.2
Segment 1	0.14	Total	10,262	100
Segment 2	0.37			
Segment 3	0.02			
Segment 4	0.48			
Segment 5	0.05			

Table 5.3 Delaney Creek ADEM SWQM Calibrated, 72 Percent Reduction, and Forest Model Predictions

Model Runs		Range of Values: Segments 1 to 5					DO at HCEPC 138	DO Average: Segments 1 to 5
		CBODu	NBOD	NH3-N	TON	DO		
9/24/2001 Calibrated Model	Concentration (mg/L)	3.40 - 9.27		0.20 - 0.23	0.86 - 1.13	0.9 - 5.6	1.5	2.4
	Loadings (lbs/day)	238.2	136.5	3.4	26.5			
9/24/2001 72% Reduction Model	Concentration (mg/L)	0.97 - 2.70		0.07 - 0.14	0.28 - 0.41	3.2 - 5.6	3.7	4.1
	Loadings (lbs/day)	66.7	38.2	0.9	7.4			
9/24/2001 100 % Forest Model	Concentration (mg/L)	0.58 - 1.62		0.11 - 0.17	0.52 - 0.68	3.5 - 5.6	3.9	4.3
	Loadings (lbs/day)	40.2	78.6	1.9	15.3			

Calibrated Model: Original EMCs and critical conditions.
72% Reduction Model: CBOD, NBOD, and NH3 EMCs reduced by 72%.
Forest Model: 100% forest land use.

Table 6.1 TMDL Components for Delaney Creek

Parameter	WLA		LA (lbs/year)	MOS	TMDL (lbs/year)	Percent Reduction
	Wastewater (lbs/year)	NPDES Stormwater (percent reduction)				
BOD	NA	72	75,289	Implicit	75,289	72
TN	NA	72	20,967	Implicit	20,967	72

NA: Not Applicable.

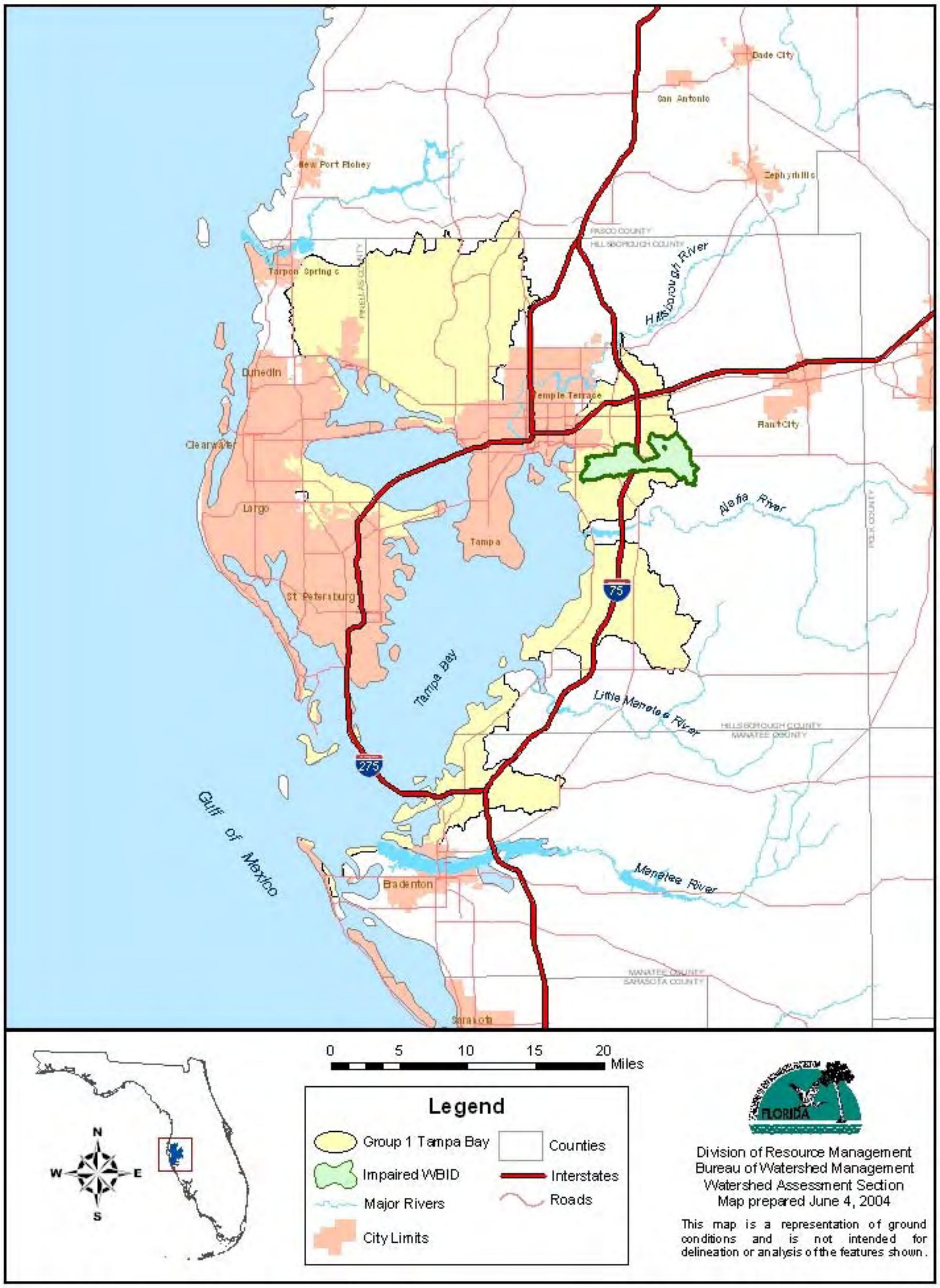

Figure 1.1. Location of the Delaney Creek Watershed and Major Geopolitical Features in the Tampa Bay Basin

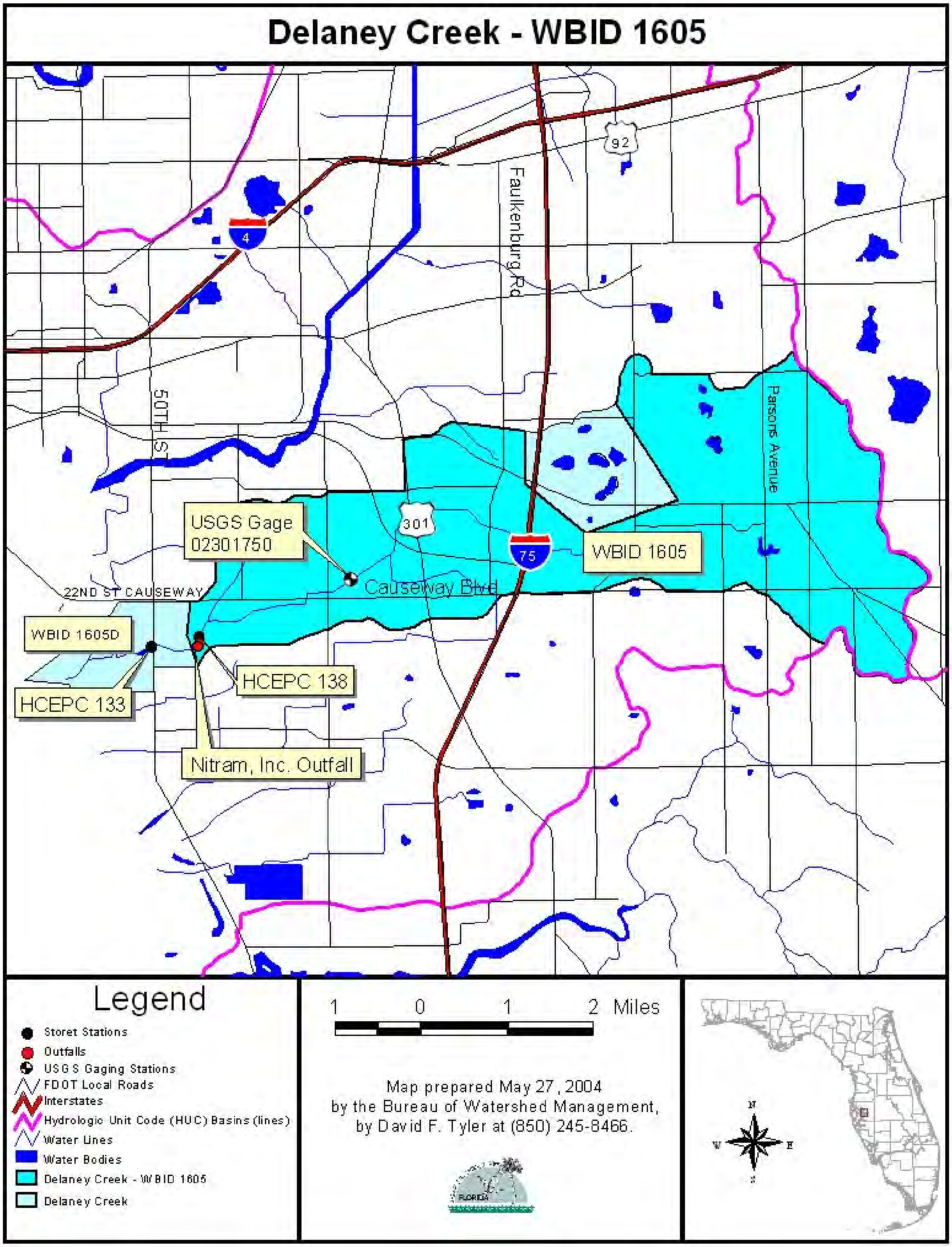

Figure 1.2. WBIDs in the Delaney Creek Watershed

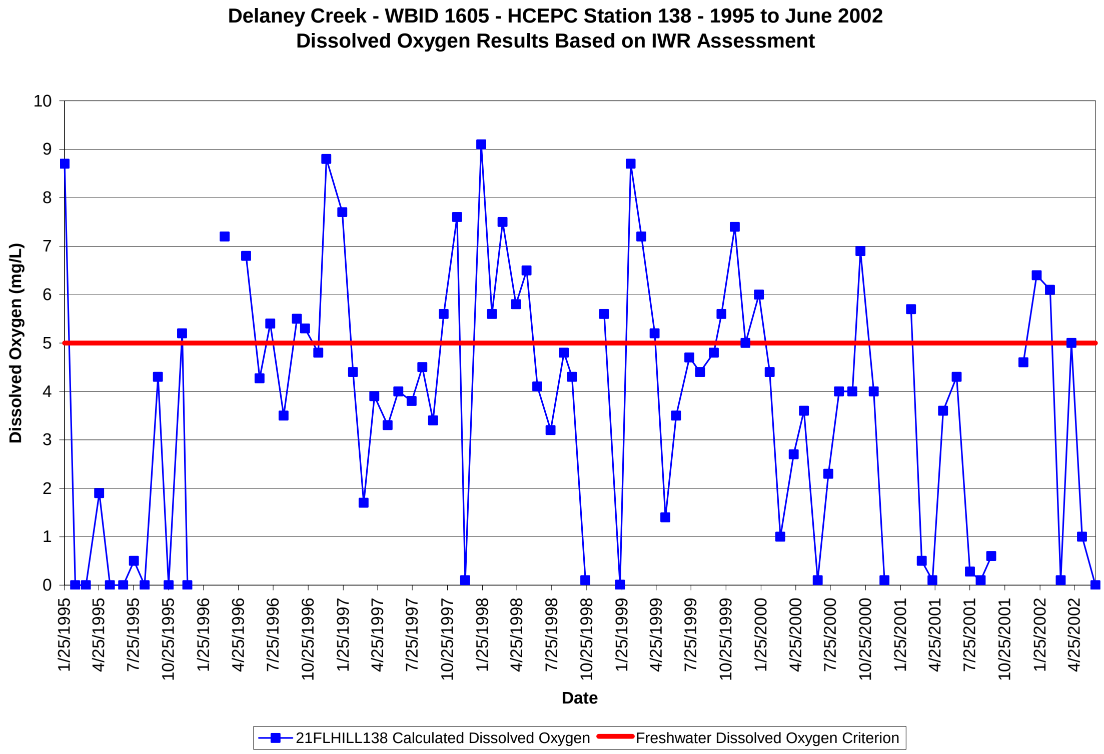

Figure 2.1. Dissolved Oxygen Results at Long-term Monitoring Station

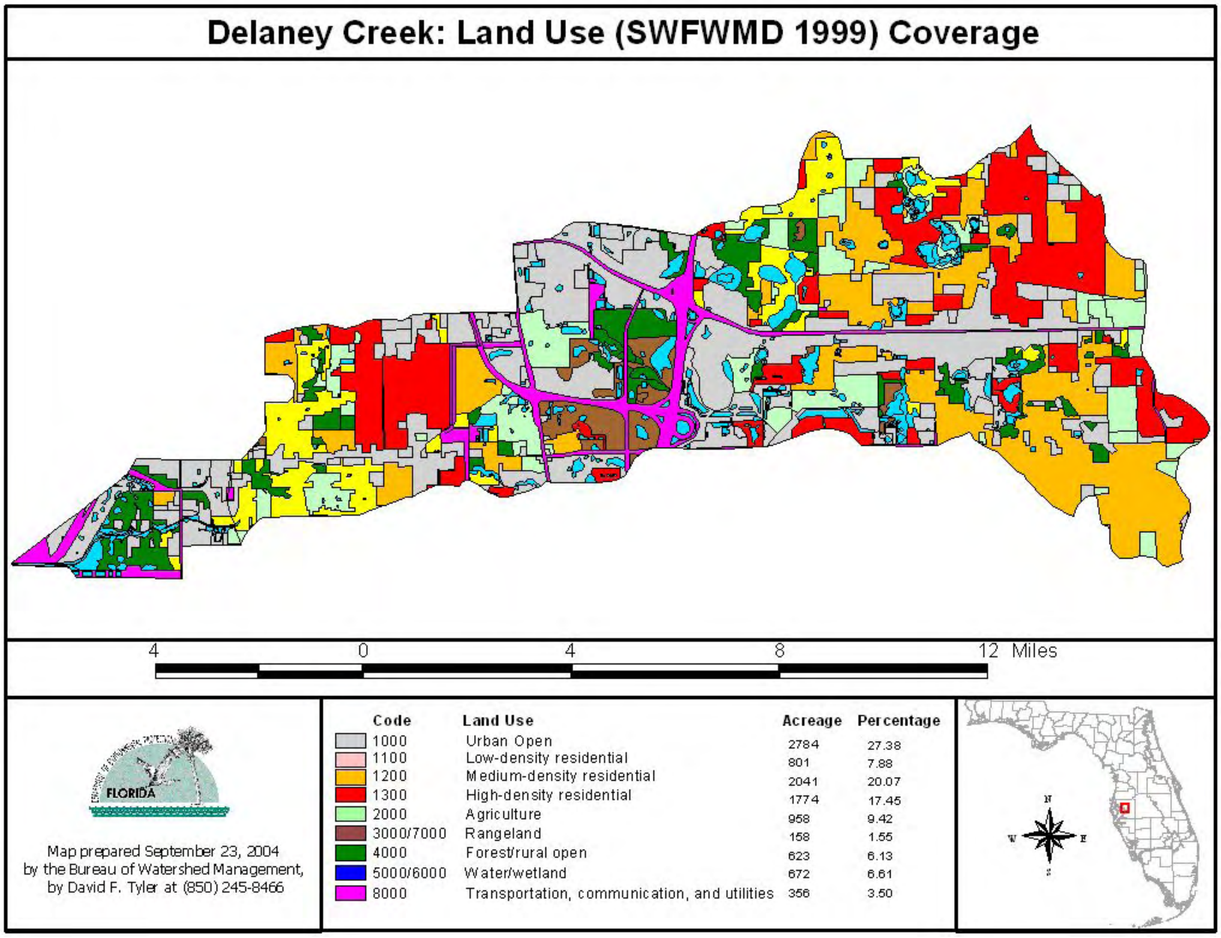

Figure 4.1. Principal Land Uses in the Delaney Creek Watershed

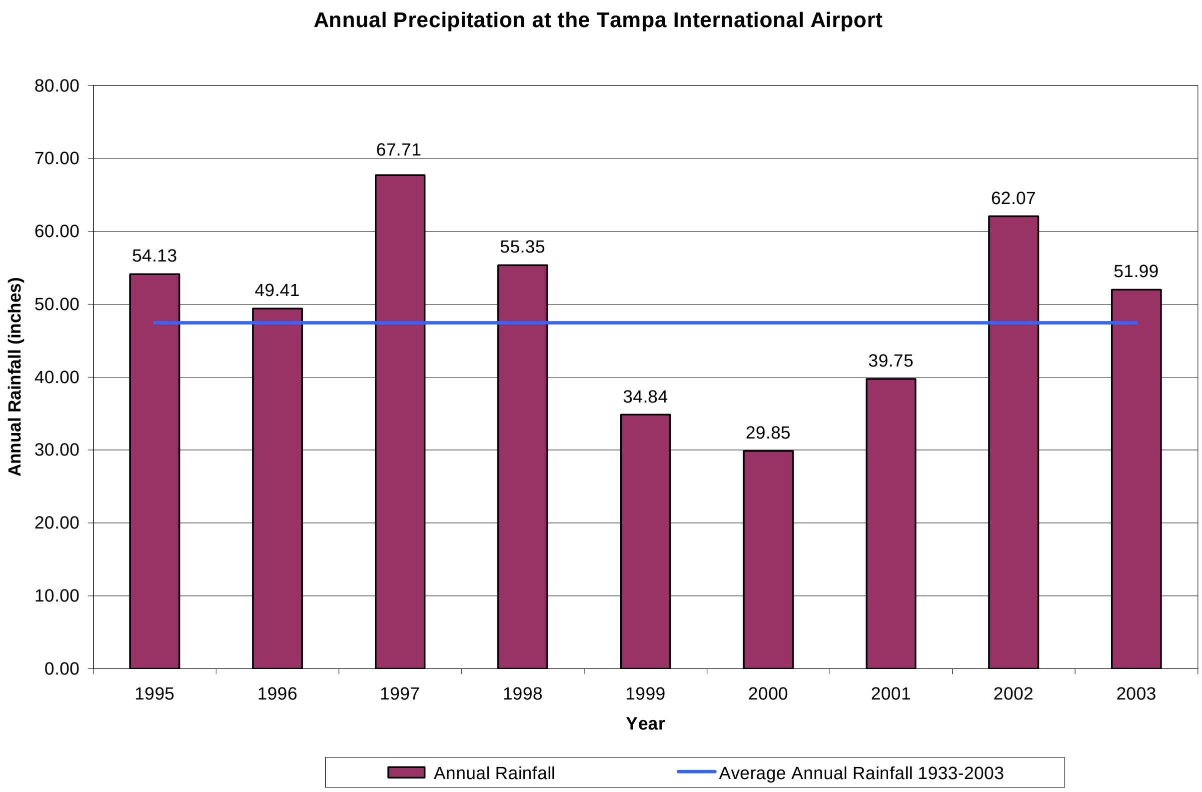

Figure 4.2 Annual Total Precipitation in the Delaney Creek Watershed

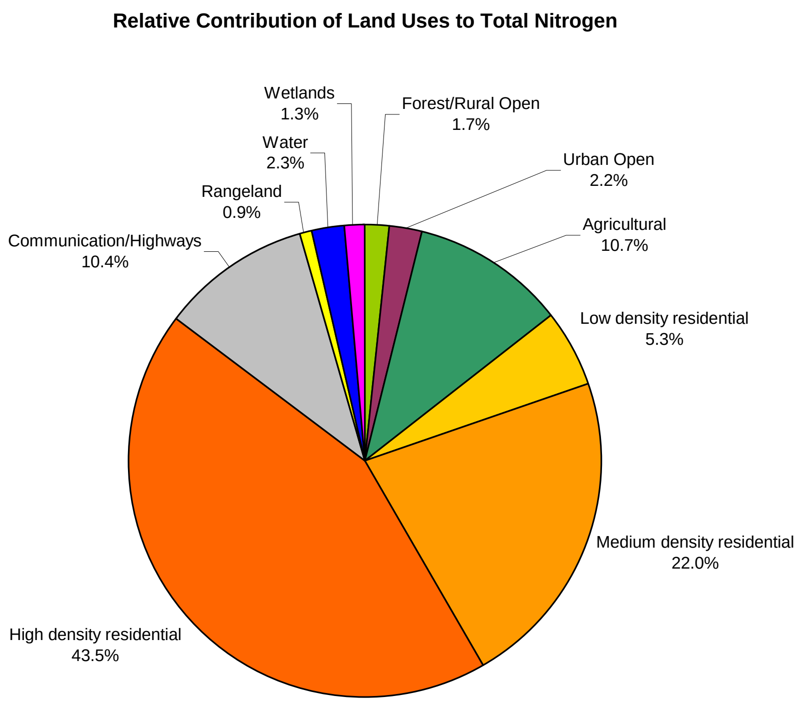

Figure 4.3 Delaney Creek Percent Contribution of Nitrogen Loads from Different Land Use Categories

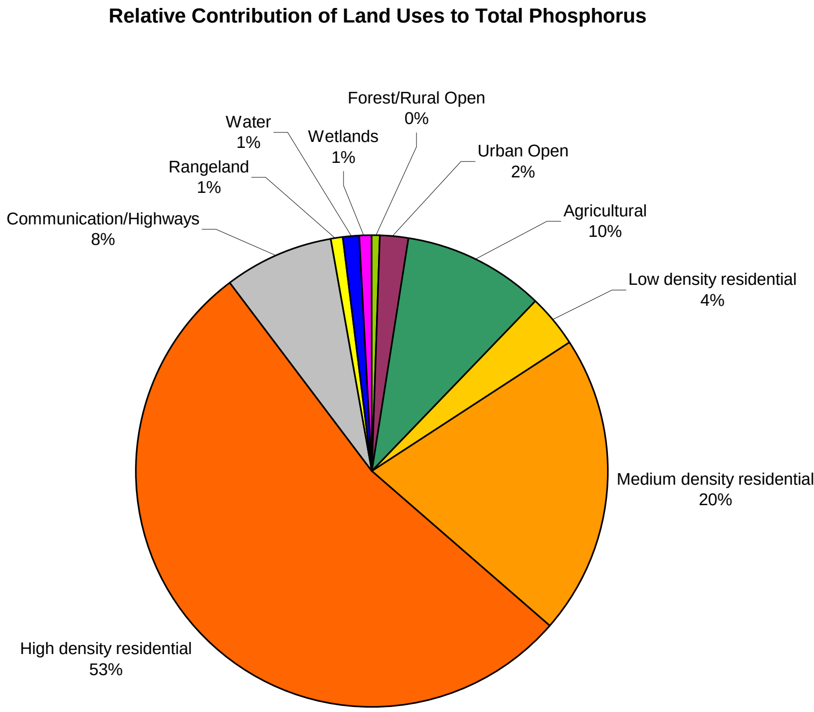

Figure 4.4 Delaney Creek Percent Contribution of Phosphorus Loads from Different Land Use Categories

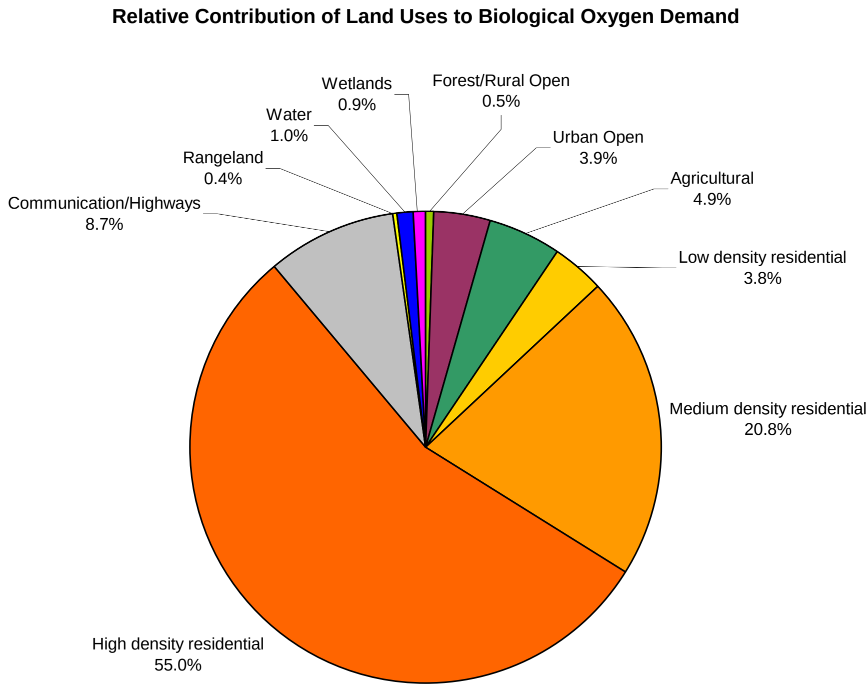

Figure 4.5 Delaney Creek Percent Contribution of Biological Oxygen Demand Loads from Different Land Use Categories